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PATENT APPLICATION
Docket No.: 45051-00006
P 1874-093 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of: Niklas STENSTRÖM et al.

For: A DIGITAL COMMUNICATION RECEIVER AND A METHOD FOR THE OPERATION THEREOF

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Type or Print Name: DOROTHY MACKINNON

Dorothy MacKinnon

Signature

BOX PATENT APPLICATION
Assistant Commissioner of Patents
Washington, D.C. 20231

Sir:

PATENT APPLICATION TRANSMITTAL LETTER

Transmitted herewith for filing, please find the following:

1. (XX) The specification of the above-referenced patent application is enclosed herewith (17 page(s) including claim(s) and Abstract).

2. (XX) 5 sheet(s) of:
x informal drawing(s) is (are) enclosed herewith.
___ formal drawing(s) is (are) enclosed herewith.

3. (X) The fees for this application have been calculated and included as shown below (Prior to calculating the fees, please enter any enclosed preliminary amendment.):

	NO. FILED	NO. EXTRA	RATE	FEE
BASIC FEE				**$710**
TOTAL CLAIMS	**17-20**	**0**	**$18**	**0**
INDEPENDENT CLAIMS	**4- 3**	**1**	**$80**	**80**
MULTIPLE DEPENDENT CLAIM(S) PRESENTED			**$270**	**270**
TOTAL FEES:				**$1060.00**
Deduct One-Half for Small Entity Status				
Assignment Recordal Fee			**$40**	**40.00**
TOTAL AMOUNT DUE:				**$1100.00**

4. X Checks in the amount of $ 1060.00 and $40.00 are enclosed herewith. Please charge any deficiency or credit any overpayment to Deposit Account No. 10-0447 .

___ Please charge my Deposit Account No. __________ in the amount of $____________. Please charge any deficiency or credit any overpayment to Deposit Account No. __________.

5. (X) An oath or declaration is enclosed herewith that is:

___ Unsigned

X Newly executed per 37 CFR 1.63(a) and (b).

___ A copy of the executed declaration filed in the prior application upon which priority is based, showing the signature or an indication thereon that it was signed; and:

___ This application is being filed fewer than all of the inventors named in the prior application and it is requested that the following name or names be deleted from the list of inventors in the prior application for this continuation or divisional application:

____

____.

___ The prior application was accorded status under 37 CFR § 1.47 and is accompanied by:

___ A copy of the decision granting a petition to accord Sec. 1.47 status to the prior application (unless all of the inventors have or legal

representatives have filed an oath or declaration to join in the prior application).

___ A copy of the subsequently executed oath(s) or declaration(s) filed by the inventor(s) or legal representative(s) that have subsequently joined in the prior application.

6. (X) The power of attorney for this application:

 X is appointed in the newly executed Oath or Declaration submitted herewith.

___ is appointed by the power of attorney enclosed herewith.

___ remains the same as originally in the parent application.

___ was changed during the prosecution of the parent application and a copy of the change in the power of attorney is enclosed herewith.

7. (XX) The correspondence address for this application shall be:

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1445 Ross Ave.
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 X which is a new correspondence address or a change therein.

___ which is the same as originally in the parent application.

___ which is the change in the correspondence address that was filed during the prosecution of the parent application.

8. (X) Priority is hereby claimed under 35 USC 119 and 172 to the following foreign applications:

Country	Serial No.	Date
Sweden	9904281-4	25 Nov 1999

and:

___ A certified copy of each application is enclosed herewith.

___ A certified copy of each application was filed in prior application Serial No. ______________.

9. ( ) A verified statement claiming small entity status under 37 CFR 1.9 and 1.27:

___ is enclosed herewith.

___ was filed in parent application Serial No. ____________, and such status remains unchanged and is requested for this application.

10. ( ) A preliminary amendment is enclosed herewith.

11. ( ) An Information Disclosure Statement with Modified PTO Form 1449 and a copy of the cited references are enclosed herewith.

12. (XX) An Assignment of the invention to TELEFONAKTIEBOLAGET L M ERICSSON (publ) with cover sheet and recordation fee is enclosed herewith for recordation by the Assignment Branch.

13. (XX) The Commissioner is hereby authorized to charge payment, or to credit any overpayment, of the following fees associated with this filing or during the pendency of this application to Deposit Account No. 10-0447.

_X_ Any patent application filing fees under 37 CFR 1.16.

_X_ Any patent application processing fees under 37 CFR 1.17.

___ The issue fee under 37 CFR 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

14. ( ) Other (specify):____
____.

15. (XX) Confirmation Postcard.

Respectfully submitted,

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EL654513438US

A DIGITAL COMMUNICATION RECEIVER AND A METHOD FOR THE OPERATION THEREOF

Technical Field

The present invention relates to digital communication receivers of the type, which is adapted to communicate with a digital communication transmitter across a communication channel and which comprises a channel estimator for providing a channel estimate of the communication channel based on a received signal, an equalizer for estimating a sequence of transmitted symbols and providing a sequence of decided symbols based on the received signal and the channel estimate, and a channel tracker for producing an updated channel estimate based on the received signal and the decided symbols and for supplying the updated channel estimate to the equalizer. The invention is also directed at a wireless communication device, for instance a radio telephone, incorporating such a digital communication receiver, for instance a TDMA receiver.

Moreover, the present invention relates to a method of operating a digital communication receiver, where a channel estimate of a communication channel between the receiver and a corresponding communication transmitter is produced from a received signal, and where a sequence of decided symbols is produced from the received signal and the channel estimate.

Description of the Prior Art

Digital communication receivers as set out above are widely used in modern communication systems. For instance, most modern systems for mobile or cellular telecommunication are based on digital communication, GSM and EDGE being two well-known examples. In a digital communication system, the digital communication receiver necessarily requires a considerable level of complexity in order to be able to

handle signal distortion, such as multi-path propagation, and still be able to decode data transmitted from a digital communication transmitter. One pronounced problem is that the radio channel between the transmitter and the receiver is time-varying, the reason for this being either that the host communication device itself (the device in which the receiver is incorporated, such as a mobile telephone) is moving, or that external objects are moving (for instance cars or trains) and generate spurious reflections of the transmitted radio wave, which may reach the receiver. There is consequently a need for a receiver technology, which is able to adapt to the time-varying real-life environment.

In Time Division Multiple Access (TDMA), used for instance in GSM, the information is transmitted in bursts from the transmitter across the radio channel to the receiver. Each burst contains information-carrying data, the contents of which are unknown a priori to the receiver, as well as a known training sequence. The training sequence is used for the purpose of synchronization and channel estimation in order to perform coherent detection of the received signal.

FIG 1 illustrates a TDMA receiver architecture of the prior art. The burst is received at an antenna 1 as a radio or microwave signal having a carrier frequency of e.g. 900 MHz or 1800 MHz. A front-end receiver 110 receives the signal from the antenna 1, processes it and converts it down to a baseband signal y_t. The front-end receiver 110 comprises various well-known components, such as filters, amplifiers, mixers and local oscillators.

The received baseband signal y_t is fed to a synchronizer 120, which is arranged to correlate the known training sequence with the received signal y_t, which contains the same training sequence, wherein the synchronizer 120 is able to locate a synchronization position. The received signal y_t is then fed together with the located synchroni-

zation position to a channel estimator 130. The channel estimator 130 is arranged to determine an estimate, H, of the radio channel.

As a next step, the received baseband signal y_t, the channel estimate H and the synchronization position are all supplied to an equalizer 140, which - based on a predetermined channel model - demodulates the received signal y_t in order to estimate the transmitted data. The channel model may for instance be expressed as:

$$Y_t = H^T U_t + e_t,$$

where $H = [h_0, \ldots, h_L]^T$ are complex-valued channel filter taps, $U_t = [u_t, \ldots, u_{t-L}]^T$ are a vector with the transmitted symbols, and e_t represents noise. This channel model is further described in *Digital Communications*, by J. Proakis, Mc Graw-Hill, New York, 1995, which is fully incorporated herein by reference.

In other words, the equalizer 140 is arranged to estimate the transmitted symbols, u_t. The equalizer 140 provides as a first output a sequence of decided symbols $\hat{u}_t$ and as a second output a qualitative information M_t (labeled Metric in FIG 1), which is a measure of how close to the transmitted symbols the estimated symbols are. This qualitative information will be used when the received signal is processed further. Commonly, the qualitative information, M_t, is based on a squared distance between the received sequence and the predicted received sequence given the decided symbols, i.e.:

$$M_t = |y_t - \hat{y}_t|^2 = |y_t - H^T U_t|^2,$$

where $U_t = [\hat{u}_t, \ldots, \hat{u}_{t-L}]^T$ is a vector with the decided symbols. It is observed that if M_t has a small value, then the estimated channel $H \approx$ the real channel H_{real}, i.e. the estimated channel filter taps are essentially correctly estimated, and furthermore $U = U_{transmitted}$, i.e. the estimated symbols are correct.

The procedure above exhibits good performance, if the host communication device is not moving too rapidly. Under such conditions, a reasonably valid assumption is that the channel filter taps H are constant during one burst of transmitted information. However, when the velocity of the host communication device increases, the radio channel starts changing over the burst, which means that the channel estimate obtained by way of the training sequence will not be valid for the entire data sequence within the burst. For instance, for a TDMA receiver used in GSM, where GMSK modulation is utilized on the 1800 MHz band, performance starts to degrade, when the velocity of the host communication device increases above 100 - 200 km/h. In an EDGE system, where 8-PSK modulation is utilized, which is more sensitive to distortions than GMSK modulation, at the same frequency, performance starts to degrade already at velocities around 50 km/h. Thus, in order to handle this problem, a channel tracker is required.

A previously known TDMA receiver architecture with a channel tracker is shown in FIG 2. As in FIG 1, the burst received by the antenna 1 is converted to a received baseband signal y_t by a front-end receiver 210. The received signal is correlated with the known training sequence by a synchronizer 220 in order to find the synchronization position, and then the channel is estimated by a channel estimator 230 in correspondence with what has been described above for channel estimator 130 of FIG 1.

The channel estimate H_0 is an initial estimate, which is used to start up an equalizing process performed by an equalizer 240. As has already been described above with reference to FIG 1, the equalizer 240 estimates a sequence of decided symbols $\hat{u}_t$ as well as qualitative information (Metric). The decided symbols $\hat{u}_t$ are supplied together with the received signal y_t to a channel tracker 250, which updates the channel estimate H_t for each time instant t =

1,...,N, where N is the duration of the burst. The channel estimate H_t is subsequently fed back to the equalizer 240, which will use the updated channel estimate in order to demodulate $\hat{u}_{t+1}$, and so on.

By using a channel tracker 250, problems can be managed, that are otherwise associated with host communication devices travelling at high velocities. However, the channel tracker 250 of the prior art receiver shown in FIG 2 is used constantly during all operational times, which means that a lot of unnecessary data processing is performed by the receiver, even when the velocity of the host communication device is low and good performance may be obtained without using a channel tracker. Moreover, since the channel tracker 250 is used all the time, the current consumption is undesiredly high for a previously known receiver, like the one illustrated in FIG 2.

Summary of the Invention

It is an object of the present to provide an improvement to digital communication receivers as described above in terms of current efficiency, i.a.

The above object has been achieved by the provision of a controller, which determines and evaluates the momentary quality of the communication channel and in response generates a control signal, which is used for enabling or disabling the channel tracker in a way, so that the channel tracker is only active in circumstances, where so is needed (when the quality of the communication channel is degraded due to e.g. high-velocity movement of the digital communication receiver).

Thus, according to the invention the channel tracker is turned on or off based on the current radio channel conditions. The decision whether to turn the channel tracker on or off may be based on the qualitative information output from the equalizer. The decision may alternatively be

based on a comparison between new channel estimates at the end and/or at the beginning of a burst and an initial channel estimate. By using the channel tracker only when necessary, processing power consumed by the receiver can be reduced, thereby allowing longer operational times between battery chargings in a portable host processing device, such as a mobile or cellular radio telephone.

Other objects, advantages and features of the present invention will appear from the following detailed disclosure of preferred and alternate embodiments, from the appended claims as well as from the drawings.

Brief Description of the Drawings

The present invention will now be described in more detail with reference to a preferred and an alternate embodiment in conjunction with the attached drawings, in which:

FIGs 1 and 2 are illustrations of two communication receivers of the prior art,

FIG 3 is a schematic block diagram illustrating a digital communication receiver according to a preferred embodiment,

FIG 4 is a schematic block diagram illustrating a digital communication receiver according to an alternate embodiment, and

FIG 5 is a triple-graph diagram illustrating the typical appearance of the qualitative information output from the equalizer of the receiver in three different situations.

Detailed Disclosure of Embodiments

Referring first to FIG 5, it is observed that the behavior of the qualitative information output (M_t, Metric) of the equalizer depends on which kind of distortion, that is affecting the received signal y_t. Three different typi-

cal behaviors of the qualitative information are shown for a receiver without any channel tracker (i.e. like the one illustrated in FIG 1) for three different scenarios. The fact that the receiver has no channel tracker means that the channel estimate obtained during the training sequence will be used for the entire burst.

The uppermost graph of FIG 5 illustrates a scenario, where white noise represents the dominating distortion. It appears that the qualitative information is quite constant during both the training sequence (TS) and the information sequence (Data).

In the second graph, the dominating distortion originates from a co-channel interferer, i.e. a remote transmitter, which is transmitting on the same carrier frequency. Since the co-channel interferer might not be synchronized with the desired signal, only some part of the burst may be distorted (in FIG 5, the rightmost portion of the second graph).

In the lowermost graph of FIG 5, the distortion is due to high velocity of the host communication device, implying that the communication channel is time-varying and changing over the burst. Since the channel taps, H, used in the equalizer are estimated during the training sequence and are therefore optimized for the center of the burst (in the example shown in FIG 5), the qualitative information increases at the end of the burst. This behavior of the qualitative information can be used according to the invention for determining whether the channel tracker needs to be enabled or not.

FIG 3 illustrates a digital communication receiver 300 according to a preferred embodiment of the invention.

In similarity with the prior art receivers shown in FIGs 1 and 2, the digital communication receiver 300 is connected to an antenna 1 for receiving a radio or microwave signal transmitted by a digital communication trans-

mitter. The radio or microwave signal is supplied to a front-end receiver 310, which converts the signal down to a received baseband signal y_t, in similarity with what has been described above with reference to FIGs 1 and 2. The front-end receiver 310 comprises various components known per se, such as filters, amplifiers, local oscillators and mixers, all of which are well-known to a man skilled in the art. Consequently, the internal structure of the front-end receiver 310 is not dealt with further herein.

The received signal y_t is supplied to a synchronizer 320, which correlates a known training sequence with the received signal y_t containing the same training sequence, wherein the synchronizer 320 is able to locate the synchronization position. The received signal y_t is supplied together with the synchronization position to a channel estimator 330, which estimates the channel, H, in a way essentially similar to what has been described with reference to FIGs 1 and 2.

The received signal y_t, the channel estimate H, and the synchronization position are then supplied to an equalizer 340, which modulates the received signal in order to obtain the transmitted data. As was described already with reference to FIGs 1 and 2, the equalizer 340 provides a first output in the form of a sequence of decided symbols $\hat{u}_t$ and a second output in the form of a qualitative information (Metric).

The decided symbols $\hat{u}_t$ are supplied together with the received signal y_t to a channel tracker 350, which will update the channel estimate H_t for each time instant $t = 1,\ldots,N$, where N is the duration of the burst. The updated channel estimate H_t is then fed back to the equalizer 340 through a switch 360, on condition that the switch 360 assumes a closed position. As will be described below, the switch 360 is controllable through a controller 370. If an updated channel estimate H_t is in fact fed back through the

closed switch 360 to the equalizer 340, the equalizer 340 will use the updated channel estimate H_c when demodulating $\hat{u}_{c+1}$, and so on.

As mentioned above, a controller 370 is provided in the communication receiver 300 shown in FIG 3. The controller 370 has a first input for receiving an updated channel estimate H_c from the channel tracker 350. The controller 370 also has a second input for reading the qualitative information Metric provided by the equalizer 340. Based on the qualitative information, the controller 370 determines and evaluates the quality of the communication channel in order to decide whether the channel tracker 350 needs to be used or not. To this end, the channel tracker 350 is enabled and disabled, respectively, via a control signal from the controller 370 (labeled "Tracker y/n?" in FIG 3). In the preferred embodiment of Fig 3, this control signal is given a first value when the channel tracker 350 is to be enabled, and a second value when the channel tracker 350 is to be disabled.

The controller 370 is coupled to an electronic memory 390 (preferably a non-volatile memory such as a flash memory, an (EE)PROM memory or an SRAM memory) for storing a predetermined threshold value, i.e. an upper limit, for the qualitative information (Metric) from the equalizer 350. This upper limit defines an acceptable limit for a difference, preferably a squared distance as described above, between symbols in the received signal (y_c) and symbols in a predicted received signal given the decided symbols ($\hat{u}_c$). In other words, the qualitative information is representative of a degree of correspondence between the received signal and the decided symbols, and the controller 370 uses the predetermined upper limit as a criterion for determining whether the qualitative information does not meet this criterion, and consequently, whether the control signal

"Tracker y/n?" will have to be given its first value, indicating that the channel tracker 350 needs to be enabled.

The controller 370 may be realized as a programmable microprocessor, a programmable logic array, other logic circuitry, discrete logic gates and components, etc.

In the communication receiver 300 shown in FIG 3, assuming that the channel tracker 350 has been enabled at some previous moment of time by the controller 370, the controller 370 is also adapted to determine whether the channel tracker 350 may be disabled (turned off). In this case, it is less suitable to use the above qualitative information produced by the equalizer 340, since the channel tracker 350 will try to follow the variations in the communication radio channel, implying that the qualitative information produced by the equalizer 340 will be approximately constant during the entire burst. Instead, the channel estimates H_c are supplied to the control unit 370, which will use these for determining whether the channel tracker 350 may be turned off or not. For instance, if $H_0 \approx H_{start} \approx H_{end}$, where H_0 is the initial channel estimate and H_{start}, H_{end} are the channel estimates at the beginning and the end of the burst, respectively, then the quality of the radio channel is acceptable, and the controller 370 determines that the channel tracker 350 may be turned off or disabled by giving the control signal "Tracker y/n?" a second value, as previously described.

On the other hand, if $||H_0 - H_{start}|| >> 0$ and $||H_0 - H_{end}|| >> 0$, the controller 340 decides to continue using the channel tracker 350 and, consequently, gives the control signal "Tracker y/n?" its first value, as previously described. The control signal "Tracker y/n?" is also supplied to the switch 360 for setting it to an open and closed position, respectively.

Referring now to FIG 4, an alternate embodiment of the communication receiver 400 is shown. The antenna 1,

front-end receiver 410, synchronizer 420, channel estimator 430, equalizer 440, channel tracker 450 and memory 490 are all essentially identical to the antenna 1, front-end receiver 310, synchronizer 320, channel estimator 330, equalizer 340, channel tracker 350 and memory 390 of FIG 3, and the description thereof is not repeated now.

In contrast to FIG 3, on the other hand, the communication receiver 400 of FIG 4 does not use the qualitative information, Metric, when determining whether the channel tracker 350 is to be enabled or disabled. Instead, the decided symbols, $\hat{u}_c$, are supplied to a second channel estimator 480. Based on the decided symbols at the beginning and the end of the burst, new channel estimates, H_{start} and H_{end}, are obtained by the second channel estimator 480 and submitted to the controller 470. If $||H_0 - H_{start}|| >> 0$ and $||H_0 - H_{end}|| >> 0$, the controller 470 decides to enable the channel tracker 450 by providing its control signal "Tracker y/n?" with a first value, wherein the channel tracker 450 will be ready to be used when the next burst is received. The decision whether to turn the channel tracker 450 off is made in essentially the same way, as has been described above with reference to FIG 3.

The digital communication receivers 300 and 400 shown in FIGs 3 and 4 are particularly well adapted to be incorporated in a portable radio telephone, such as a GSM mobile telephone. Alternatively, a digital communication receiver according to the invention may very well be incorporated in a base station in a mobile telecommunication system, such as a GSM base station. However, the present invention is not limited to these examples, and the digital communication receiver according to the invention may be incorporated in virtually any host communication device. Other embodiments than the ones described above are equally applicable within the scope of the invention, as defined by the appended independent claims.

CLAIMS

1. A digital communication receiver (300; 400) adapted to communicate with a digital communication transmitter across a communication channel, the digital communication receiver comprising:

a channel estimator (330; 430), adapted to provide a channel estimate (H_0) of the communication channel based on a received signal (y_t),

an equalizer (340; 440), adapted to estimate a sequence of transmitted symbols (u_t) and provide a sequence of decided symbols ($\hat{u}_t$) based on the received signal and the channel estimate, and

a channel tracker (350; 450), adapted to produce an updated channel estimate (H_t) based on the received signal (y_t) and the decided symbols ($\hat{u}_t$), and adapted to supply the updated channel estimate to the equalizer,

characterized by

a controller (370; 470), which is operatively coupled to the equalizer (340; 440) and the channel tracker (350; 450), wherein

said controller is adapted to receive channel quality indicative data (Metric; H_{start}, H_{end}) associated with an output from the equalizer, to determine whether said channel quality indicative data fail to meet a predetermined criterion, and, if so, to supply an enabling control signal ("Tracker y/n?") to the channel tracker, and wherein

said enabling control signal is adapted to switch the channel tracker from a disabled state, in which no updated channel estimate (H_t) is produced, to an enabled state, in which said updated channel estimate (H_t) is produced.

2. A digital communication receiver as in claim 1, wherein said channel quality indicative data (Metric) are produced by the equalizer (340) and represents a degree of

correspondence between the received signal (y_c) and the decided symbols ($\hat{u}_c$).

3. A digital communication receiver as in claim 2, wherein said channel quality indicative data (Metric) are computed by the equalizer (340) as a squared distance between symbols in the received signal (y_c) and symbols in a predicted received signal given the decided symbols ($\hat{u}_c$).

4. A digital communication receiver as in any preceding claim, wherein said predetermined criterion is stored as a threshold value in an electronic memory (390) operatively coupled to the controller (370).

5. A digital communication receiver as in claim 1, further comprising a second channel tracker (480), which is operatively coupled to the equalizer (440) and the controller (470), wherein

said channel quality indicative data (H_{start}, H_{end}) are produced by the second channel tracker in the form of additional channel estimates (H_{start}, H_{end}) based on the decided symbols ($\hat{u}_c$) from the equalizer, and wherein

the controller (470) is adapted to compare the additional channel estimates with an initial channel estimate (H_0) and to produce said enabling control signal ("Tracker y/n?"), if the comparison indicates a difference bigger than said predetermined criterion.

6. A digital communication receiver as in any preceding claim, capable of Time Division Multiple Access communication.

7. A digital communication receiver (300; 400) adapted to communicate with a digital communication trans-

mitter across a communication channel, the digital communication receiver comprising:

a channel estimator (330; 430), adapted to provide a channel estimate (H_0) of the communication channel based on a received signal (y_t),

an equalizer (340; 440), adapted to estimate a sequence of transmitted symbols (u_t) and provide a sequence of decided symbols ($\hat{u}_t$) based on the received signal and the channel estimate, and

a channel tracker (350; 450), adapted to produce an updated channel estimate (H_t) based on the received signal (y_t) and the decided symbols ($\hat{u}_t$), and adapted to supply the updated channel estimate to the equalizer,

characterized by

a controller (370; 470), which is operatively coupled to the channel tracker (350; 450), wherein

said controller is adapted to compare said updated channel estimate (H_t) with an initial channel estimate (H_0) and to supply a disabling control signal ("Tracker y/n?") to the channel tracker, if the comparison indicates a difference smaller than a predetermined criterion, and wherein

said disabling control signal is adapted to switch the channel tracker from an enabled state, in which said updated channel estimate (H_t) is produced, to a disabled state, in which no updated channel estimate (H_t) is produced.

8. A digital communication receiver as in claim 7, the receiver being capable of Time Division Multiple Access (TDMA) communication, wherein said updated channel estimate relates to the beginning and/or the end of a TDMA burst.

9. A wireless communication device, comprising a digital communication receiver as in any preceding claim.

10. A wireless communication device as in claim 9, wherein the device is a radio telephone.

11. A wireless communication device as in claim 9, wherein the device is a base station in a cellular communication system.

12. A method of operating a digital communication receiver (300, 400), wherein a channel estimate (H_0) of a communication channel between the receiver and a digital communication transmitter is produced from a received signal (y_t), and wherein a sequence of decided symbols ($\hat{u}_t$) is produced from the received signal and the channel estimate, **characterized** by the steps of

a) receiving channel quality indicative data (Metric; H_{start}, H_{end}), which are directly or indirectly associated with said sequence of decided symbols ($\hat{u}_t$);

b) determining whether said channel quality indicative data fail to meet a predetermined criterion; and

c) conditionally, if the predetermined criterion is not met, switching from a disabled state, in which no updated channel estimate (H_t) is produced, to an enabled state, in which an updated channel estimate (H_t) is produced from said received signal (y_t) and said sequence of decided symbols ($\hat{u}_t$).

13. A method as in claim 12, further comprising the step of

a') producing said channel quality indicative data (Metric) as a calculated squared distance between symbols in the received signal (y_t) and symbols in a predicted received signal given the decided symbols ($\hat{u}_t$).

14. A method as in claim 12, further comprising the step of

a'') producing said channel quality indicative data as additional channel estimates (H_{start}, H_{end}) based on the decided symbols ($\hat{u}_t$), wherein

said predetermined criterion is a degree of correspondence between said additional channel estimates and an initial channel estimate.

15. A method of operating a digital communication receiver (300, 400), wherein a channel estimate (H_0) of a communication channel between the receiver and a digital communication transmitter is produced from a received signal (y_t), and wherein a sequence of decided symbols ($\hat{u}_t$) is produced from the received signal and the channel estimate, **characterized** by the steps of

a) receiving an updated channel estimate (H_t) based on the decided symbols ($\hat{u}_t$);

b) comparing said updated channel estimate (H_t) with an initial channel estimate (H_0); and

c) conditionally, if the comparison indicates a difference smaller than a predetermined criterion, switching from an enabled state, in which an updated channel estimate (H_t) is produced from said received signal (y_t) and said sequence of decided symbols ($\hat{u}_t$), to a disabled state, in which no updated channel estimate (H_t) is produced.

16. A method as in claim 15, wherein the receiver is capable of Time Division Multiple Access (TDMA) communication and wherein said updated channel estimate relates to the beginning and/or the end of a TDMA burst.

ABSTRACT

A digital communication receiver (300) communicates with a digital communication transmitter across a communication channel and has: a channel estimator (330), which provide a channel estimate (H_0) of the communication channel based on a received signal (y_t); an equalizer (340), which estimates a sequence of transmitted symbols (u_t) and provides a sequence of decided symbols ($\hat{u}_t$) based on the received signal and the channel estimate; and a channel tracker (350), which produces an updated channel estimate (H_t) based on the received signal (y_t) and the decided symbols ($\hat{u}_t$), and which supplies the updated channel estimate to the equalizer. The digital communication receiver (300) also has a controller (370), which receives channel quality indicative data (Metric) associated with an output from the equalizer, determines whether these data fail to meet a predetermined criterion, and, if so, supplies an enabling control signal ("Tracker y/n?") to the channel tracker, so that the channel tracker will switch from a disabled state, in which no updated channel estimate (H_t) is produced, to an enabled state, in which said updated channel estimate (H_t) is produced.

To be published together with FIG 3.

FIG 1

PRIOR ART

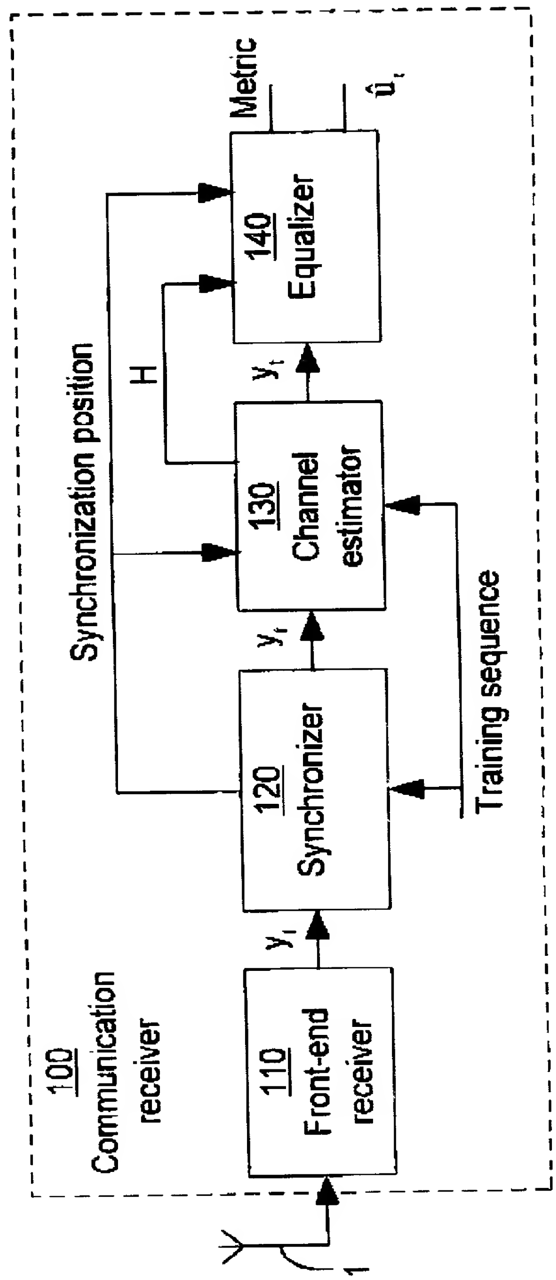


FIG 2

PRIOR ART

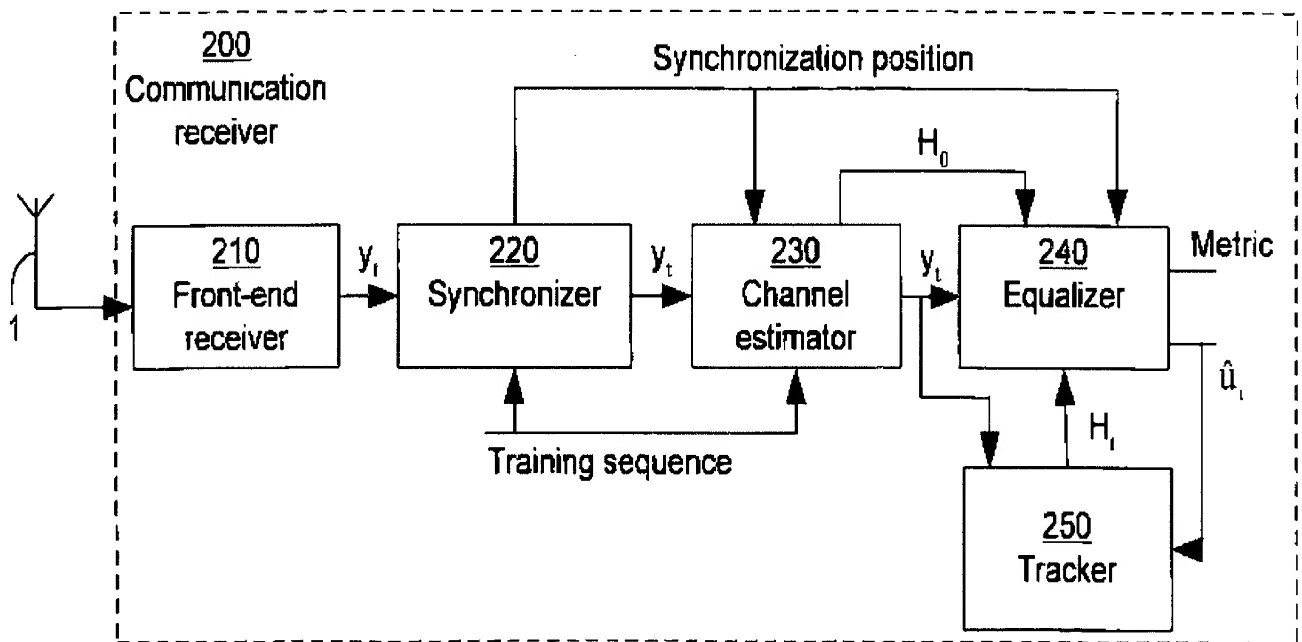


FIG 3

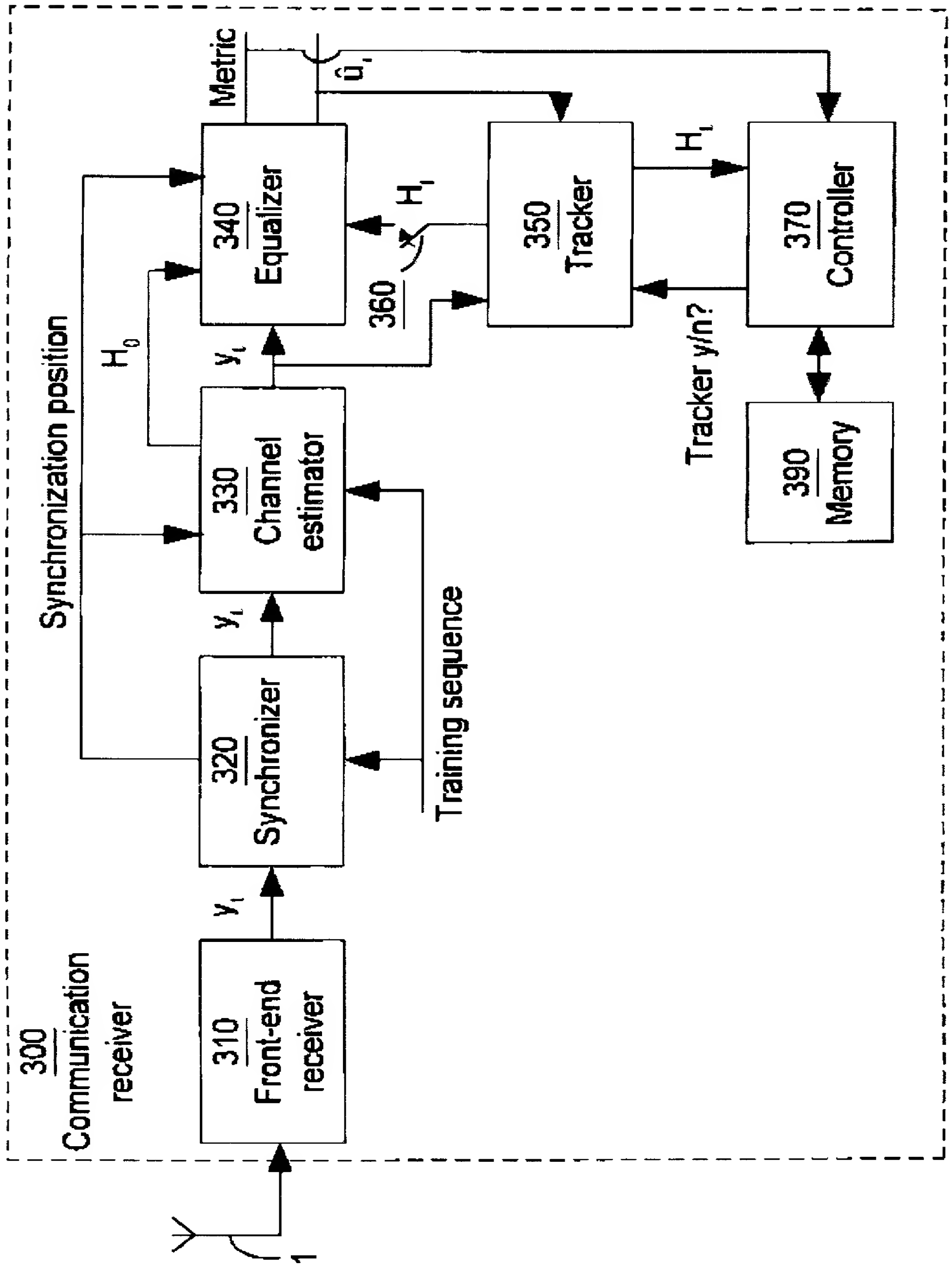
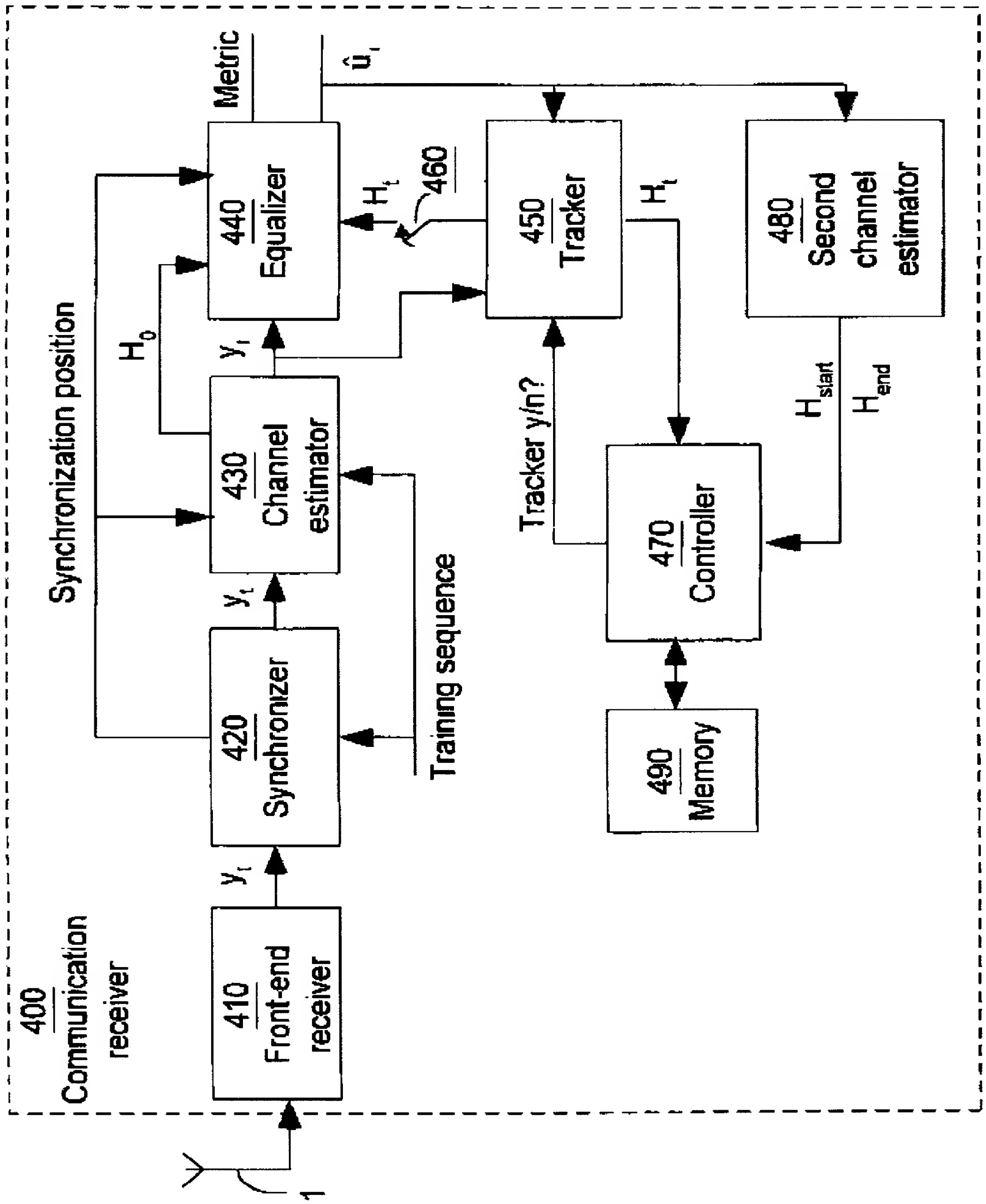

300
Communication receiver
310
Front-end receiver
320
Synchronizer
330
Channel estimator
340
Equalizer
350
Tracker
360
370
Controller
390
Memory
Synchronization position
Training sequence
Tracker y/n?
Metric
y_t
H_0
H_t
$\hat{u}_t$
1

FIG 4


400
Communication receiver
410
Front-end receiver
1
y_t
420
Synchronizer
Training sequence
Synchronization position
y_t
430
Channel estimator
H_0
y_t
440
Equalizer
Metric
$\hat{u}_t$
H_t
460
450
Tracker
H_t
Tracker y/n?
470
Controller
490
Memory
480
Second channel estimator
H_{start}
H_{end}

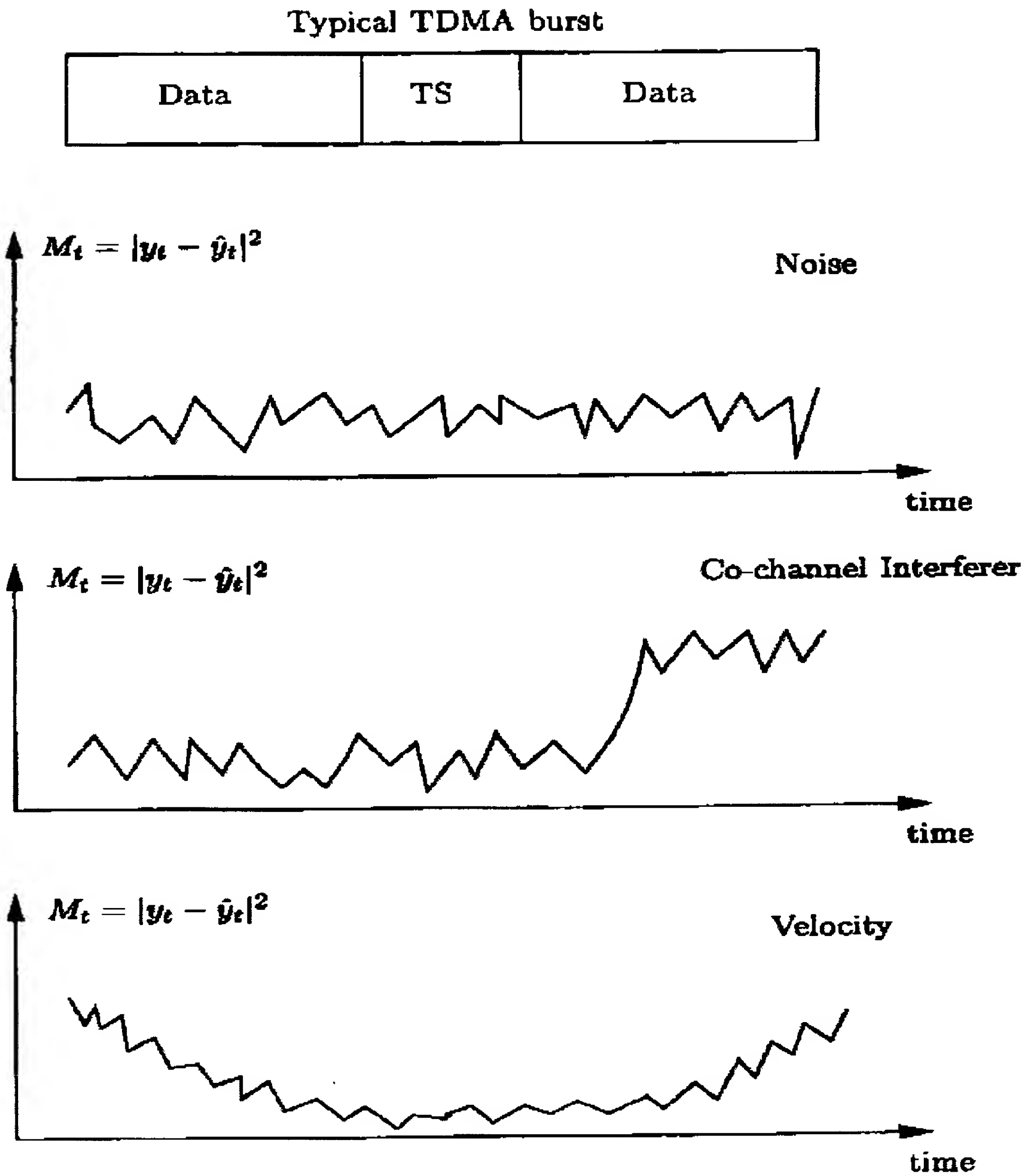

Typical TDMA burst
Data
TS
Data
$M_t = |y_t - \hat{y}_t|^2$
Noise
time
$M_t = |y_t - \hat{y}_t|^2$
Co-channel Interferer
time
$M_t = |y_t - \hat{y}_t|^2$
Velocity
time

FIG 5

PATENT APPLICATION
DOCKET NO.: P12245US

RULES 63 AND 67 (37 C.F.R. 1.63 and .67)
DECLARATION AND POWER OF ATTORNEY

FOR UTILITY/DESIGN/CIP/PCT NATIONAL APPLICATIONS

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name; and

I believe that I am the original, first and sole inventor (if only one name listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A digital communication receiver and a method for the operation thereof

---

the specification of which· (mark only one)

X (a) is attached hereto.
___ (b) was filed on ________,199__ as Application Serial No. ________ and was amended on ________ (if applicable)
___ (c) was filed as PCT International Application No. PCT/________ on ________ and was amended on ________ (if applicable).
___ (d) was filed on ________ as Application Serial No.______ and was issued a Notice of Allowance on ________.
___ (e) was filed on ______ and bearing attorney docket number________:

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above or as allowed as indicated above.

I acknowledge the duty to disclose all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56. If this is a continuation-in-part (CIP) application, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C § 112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability of the application as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this CIP application

I hereby claim foreign priority benefits under 35 U.S.C § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and also identified below any foreign application for patent or inventor's certificate filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which my priority is claimed or, (2) if no priority is claimed, before the filing date of this application:

PRIOR FOREIGN PATENTS

Number	Country	Month/Day/Year Filed	Date first laid-open or Published	Date patented or Granted	Priority Claimed Yes	No
9904281.4	SE	11/25/99			X	

I hereby claim the benefit under 35 U.S.C. § 120/365 of any United States application(s) listed below and PCT international applications listed above or below.

PRIOR U.S. OR PCT APPLICATIONS

Application No (series code/serial no.)	Month/Day/Year Filed	Status (pending, abandoned, patented)

I hereby appoint:

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THOMAS E. ANDERSSON Reg No. 37,063
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JOHN C. GATZ Reg. No. 41,774
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STEPHEN G. RUDISILL Reg. No. 20,087
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all of the firm of **JENKENS & GILCHRIST, P.C.**, 3200 Fountain Place, 1445 Ross Avenue, Dallas, Texas 75202-2799, as my attorneys and/or agents, with full power of substitution and revocation, to prosecute this application, provisionals thereof, continuations, continuations-in-part, divisionals, appeals, reissues, substitutions, and extensions thereof and to transact all business in the United States Patent and Trademark Office connected therewith, to appoint any individuals under an associate power of attorney and to file and prosecute any international authorities, and I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct them in writing to the contrary.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so are made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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